be used, too, on larger yachts, and for pleasure-boats by those who can afford them, and where there are facilities for reaching the battery. An important use just at present is to call attention to the possibilities of storage-batteries, and to encourage inventors to improve the present uneconomical and weighty types.

The launch in question is twenty-eight feet long, has six feet beam and a depth of three feet. The batteries are under a couple of benches running fore and aft. The motors are under the deck aft. The motors are governed by a handle near the steering-wheel. With seven-horse power the boat is said to make twelve miles, with two-horse power about six miles, an hour.

COST OF ELECTRIC TRACTION. — The following table is the result of calculations made by experts on the cost of horses, cables, and electric storage-cars on the Fourth Avenue street-car line, New York: —

	Electric.	Horse.	Cable.
Cost of cars	1	.54	.81
Motive power	1	1.45	1.06
Construction of roadway	1	.53	2.09
Depreciation and repairs	1	1.47	2.04
Operating expenses (including wages)	1	3.38	1.71
Total	5	7.37	7.71
Average	1	1.47	1.55

For this road, then, storage-cars would, provided the estimate be correct, be much cheaper than any other system. Fortunately, these figures will have a practical test, since the Julien Company is equipping ten storage-cars for the line. So much for storage-cars. Where overhead wires are permissible, there seems no doubt of the advantages of electric traction. The Union Passenger Railway in Richmond, with the Sprague system, is carrying over 250,000 passengers a month, at a cost of less than 1½ cents a car-mile; the total operating expenses, every thing included, being only 47 per cent of the receipts. What electric railway systems using a conduit between the tracks for their conductor can do, remains to be seen. For haulage in mines, the reports are most encouraging. Mr. Shaefer, at a meeting of the Engineers' Club of Philadelphia, stated that the cost per ton-mile in the anthracite-coal mines was as follows: mules, 1.82 cents; steam, .6 cent; electric motors, .4 to .67 cent. Considering the very obvious advantages of electricity as compared with steam in mining-work, the figures are strongly in favor of electricity for traction in mines. Outside of cost, electricity presents the advantages of cleanliness and perfect control; and the above figures, taken in two cases from actual and continued experience, show, that, when properly applied, it is superior in economy as well.

LIGHTNING-FLASHES. — W. Kohlrausch has estimated the current and quantity of electricity in a lightning-flash. He calculates that it will take 9,200 ampères to melt a copper rod of 2.5 centimetres diameter. Such a current concentrated in a flash would contain from 52 to 270 coulombs, which would decompose from 5 to 25 milligrams of water, and form 9 to 45 cubic centimetres of explosive gas. If this energy were stored up and distributed for electric-lighting, it would require from 7 to 35 flashes to keep one incandescent lamp lighted for an hour.

AN ELECTRO-CHEMICAL RADIOPHONE. — The *London Electrician* gives an abstract of a communication to the Académie des Sciences by MM. Chaperon and Mercadier, describing a galvanic cell made by them which is sensitive to the action of light. "It consists of a plate of bright silver covered by the electrolysis of sulphate of sodium with a thin layer of sulphide of silver, immersed in some electrolyte other than an alkaline sulphide, water containing a trace of sulphuric acid being as good as any thing. The electro-motive force is feeble and variable, and the cell polarizes rapidly, but its current undergoes an instantaneous change when exposed to daylight or even to weak artificial light. The authors investigated the rapidity of action by exposing the cell to the beam of the oxyhydrogen light, made intermittent by passing through a revolving wheel pierced with holes. A telephone was included in the battery circuit, and sounds were produced so high in the scale as to correspond to more than 1,000 vibrations a second, which showed that the electro-chemical effect must be produced in less than $\frac{1}{2000}$ of a second. No corresponding change was produced in the resistance of the cell: so the effect of the light must be to cause a variation in the electro-motive force.

EXPERIMENTS ON THE ELECTRIC ARC. — The fall of potential in the electric arc has been generally held to be due to two causes, — a resistance increasing with the length of the arc, and a counter electro-motive force independent of the length. This may be expressed by the formula $E = a + bl$, where a and b are constants, and l is the length of the arc. Dr. Lecher, in a paper in the *Centralblatt für Electrotechnik*, describes experiments which tend to disprove this view. He first found that the resistance of the arc does not increase very rapidly when it is extinguished: this he showed by putting the primary of an induction-coil in the arc-lamp circuit, first pulling the carbons apart, and second extinguishing the lamp. There was a spark in the secondary in the first case, but not in the second: so the resistance, on extinction, could not have increased with very great rapidity. This being the case, Dr. Lecher placed in the lamp-circuit a galvanometer, the needle held against a stop for the direct current, but free to swing in the opposite direction. He then suddenly cut out the feeding-current, and there was no swing of the galvanometer-needle in the opposite direction: so, if there was a counter electro-motive force in the arc, it must have disappeared at the same time the feeding-current ceased. To see if the difference of potential of the arc depends on the temperature of the carbons, they were heated by a blowpipe. With a normal difference of 42 volts, this rose to 48 volts when the positive, and 52 volts when the negative, carbon was heated. When the carbons are horizontal, the potential difference is less than when they are vertical, on account of the higher temperature in the latter case. When the carbons are cooled, the potential difference is less. For example, representing the difference by $a + bl$,

	a	bl	
Carbons horizontal, uncooled	33	$4.5l$	±1.5 volts.
" vertical, "	35.5	$5.7l$	±1.5 "
" horizontal, cooled	25	$5.0l$	±3.0 "

To find in what part of the arc the fall of potential really occurred, a carbon rod of small diameter was introduced into the arc, and the difference of potential between it and the carbon electrodes was taken. It was found that the difference of potential between the +carbon and *any* part of the arc was about 36 volts. This being the case, it is assumed that the rest of the fall of potential is at the —carbon. Dr. Lecher also experimented on the nature of the current forming the arc, but the method used is questionable. He claims that his investigations show: 1. The existence of a back electro-motive force is doubtful; 2. The difference of potential is affected by temperature; 3. If the negative electrode is platinum or iron, the discharge is discontinuous.

THE RADIO-MICROPHONE. — Mr. C. Vernon Boys has described before the Royal Society an instrument for measuring very small changes of temperature. "It is an extremely delicate form of thermopile, consisting of a square frame made of one turn of one square centimetre, of which three sides are thin copper wire, and the fourth is a compound bar of antimony and bismuth, each piece being $5 \times 5 \times \frac{1}{6}$ mm., soldered edge to edge. This frame is supported by a thin rod to which is fastened a mirror, and the whole is hung by a tortion fibre in the field of a powerful magnet. When radient energy falls on the centre of the compound bar, the frame is deflected, and the amount of deflection measures the energy. Adopting suitable dimensions, and using a very strong field, an instrument may be made capable of showing a change of temperature of the junction of one thousand-millionth of a degree."

BOOK-REVIEWS.

Forms of Animal Life, a Manual of Comparative Anatomy. By GEORGE ROLLESTON. 2d ed., revised by W. Hatchett Jackson. Oxford, Clarendon Pr. 8°. (New York, Macmillan, $9.)

THOSE who in years past have been familiar with Rolleston's 'Forms of Animal Life' will welcome the very much enlarged and modernized edition that makes its appearance after a lapse of seventeen years. Opinions may and will differ as to how the principles of comparative anatomy are best taught, but no one will deny

that he will be well taught who follows this bulky manual faithfully through. The work has been thoroughly revised, largely rewritten, and very much increased in size, by Professor Rolleston's collaborator and successor, Mr. W. H. Jackson. For the benefit of those who are not familiar with the former edition (and there are comparatively few students in recent years in America who are familiar with it), a few words relative to the scope of the volume may be given. The first part of the volume is essentially a laboratory guide, illustrated by plates, of the anatomy of various selected types of animal structure; the second and larger part contains systematic morphological descriptions of the classes and higher divisions of the animal kingdom, with briefer discussions of the different orders, both fossil and recent. The descriptions are very comprehensive, essentially comparative, and modern. Not the least valuable part of the work are the bibliographies appended, in both parts, to type or class, and so arranged as to open up to the student special lines of study in any direction he may select.

The work is alike valuable to the special student and teacher of comparative anatomy, and will be scarcely less useful to the paleontologist and college teacher of zoölogy, as well as forming an excellent adjunct and continuation to Huxley and Martin. To the undergraduate, or even non-specialist post-graduate, almost its only service will be that of a work of reference. As Professor Rolleston says, the distinctive character of the book "consists in its attempting to so combine the concrete facts of zoötomy with the outlines of systematic classification as to enable the student to put them for himself into the natural relations of foundation and superstructure." But no student can appreciate or grasp the broad morphological principles underlying classification until he has first familiarized himself with the details upon which those principles are based. In Huxley and Martin's 'Biology' the other extreme is taken, and facts, only, presented; in the present work we believe that a much more thorough acquaintance with the actual structure of animal bodies is needed than is presented in the first part, before the student can avail himself of the more systematic morphological portion. The work is not complete in itself: it needs and will be supplemented by others; nevertheless it is one that no zoötomist or zoölogist can afford to be without.

A Course of Elementary Instruction in Practical Biology. By T. H. HUXLEY. Revised and edited by G. B. Howes and D. H. Scott. London and New York, Macmillan. 16°. $2.60.

HUXLEY and Martin's 'Practical Biology' has long since won an enviable place as a text-book in our best institutions, and the present edition contains many important improvements that will meet the approbation of teachers. In size, the present is nearly twice that of the former edition, and its arrangement has been materially changed. Especially do we approve of the principle, that has already been accepted by other authors in similar treatises, of starting the student in on work that is more familiar to him, and gradually leading him to less familiar fields, rather than the adherence to a more logical and systematic but less practical view of living structure. In the present edition the arrangement has been so changed that the student is first taken through a careful study of the frog, and then follows successively the study of the cray-fish, earth-worm, snail, mussel, polyps, animalcules, yeast, protococcus *Spirogyra*, bacteria, moulds, stoneworts, fern, and bean. Even with the present arrangement, we believe that the student's interest would be sharpened, and his skill increased, by a preliminary study of the best-known and most familiar of all structures, the human body. The portion devoted to the frog has been most largely increased; and the additions of the earth-worm, snail, and *Spirogyra* add to the value of the book. The appendix is a happy addition to the work, and is a good, fresh, and succinct account of microscopic material and technique.

The work is undoubtedly accurate: the authors' names are not needed as a guaranty of this. The omission of figures and plates is objectionable to some; but the true use of the work, that of a guide to the student in the examination of specimens for himself, neither requires nor desires such. It is too advanced for the general undergraduate student, but is excellent for post-graduate work in preparation for medical studies. Some day, though we fear it may be far in the future, such preliminary work as this will be required of all medical students: it would go far towards mitigating the very just opprobrium under which most medical colleges of our country now suffer, — that of being the most unscientific of all scientific schools. The work would be improved by a more comparative morphological treatment. But little is said of the general principles underlying structure, and the relations of the general types are not made apparent, as they should be.

A Popular Zoölogy. By J. DORMAN STEELE and J. W. P. JENKS. New York and Chicago, Barnes. 12°. $1.40.

First Lessons in Zoölogy. By A. S. PACKARD. 2d ed. New York, Holt. 12°. $1.

BOTH of the above text-books are by well-known authors, coming simultaneously from Brown University, and both are worthy of commendation; but both are not of like merit in all respects, nor adapted for the same class of pupils. Steele and Jenks's book is designed to interest and instruct; Packard's, to instruct and interest. The former is more elementary and popular; the latter, for a somewhat older grade of pupils, and is more scientific. The one deals with the familiar forms of life more fully, — there is an undue amount on birds, — and is rather too much after the style of Tenney; Packard's work is more philosophical, and treats of principles rather than of details.

If is very difficult in a text-book on zoölogy, especially one intended for young pupils, to hit the happy mean between meaningless details and a dry, uninteresting compendium of comparative anatomy. Furthermore, the value of an elementary zoölogy depends upon who the teacher is. If he is, as is too often the case, one who knows as much about the principles of zoölogy as he does of those of the Aztec language, then no book will be of much value; if he is a good zoölogist himself, he does not rely very exclusively upon any text-book. For the pupil who must depend largely upon himself, Steele and Jenks's book, with its numerous good illustrations and anecdotal style, can be recommended; but, for the more scientific yet interesting application of the principles of animal life and its classification by a qualified teacher, the excellency of Packard's work cannot be gainsaid. The additions in the present edition of the last work are confined to the *Insecta*, *Ctenophores*, and the horseshoe crab.

NOTES AND NEWS.

IN 1887 an association was formed in Ireland for the promotion of silk-culture in the south of the island. The hope was to utilize land now devoted to very unproductive crops. The Journal of the Society of Arts states that the river-valleys of Munster are especially suited for the growth of the mulberry-tree. The present effort to introduce silk-cultivation divides itself into two parts, — first the cultivation of the mulberry-tree, and next the rearing of cocoons. To accomplish these objects of the association it is proposed, and is actually being done on a small scale, to distribute mulberry-trees among those who last year reared such silk as to "equal any Italian or other silk." Count Dandalo, in his Italian work on the silkworm, says that Ireland, from many circumstances, appears peculiarly favorable to the cultivation of silk. The experiment of rearing silkworms is being tried by about thirty families, but large results are not expected at once, as the imported mulberry-trees will not leaf well in the first year. It is remarked, that, if the re-afforesting of Ireland be desirable, some of the trees should be the useful mulberry. Another part of the scheme is to introduce reeling-machines, which can be used by ladies in their own homes. Sericulture has been in every country rather an occupation for the family than for the factory, which gives it a special claim to attention, at a time when those whose circumstances forbid them from seeking employment outside their own homes are suffering keenly from the general depression.

— The Society of Science of Harlem has just published Volume I. of the works of the illustrious Huygens. This is a volume which will be of special value to the physicists and historians, and we can but commend this republication of the works of the pioneers in science. The Physical Society of France has done a similar piece of service in republishing the works of Coulomb and Ampère.